

concentrations and can be dispersed relatively easily in the mixture. Under these circumstances, water is used to reduce the viscosity (initially from thousands to hundreds of thousands centipoise). Water-based capsules, such as those made from a protein or polysaccharide material, for example, could be dispersed in such a medium and coated, provided the viscosity could be sufficiently lowered. Curing in such systems is generally by ultraviolet radiation.

Like other encapsulated electrophoretic displays, the encapsulated electrophoretic displays of the present invention provide flexible, reflective displays that can be manufactured easily and consume little power (or no power in the case of bistable displays in certain states). Such displays, therefore, can be incorporated into a variety of applications and can take on many forms. Once the electric field is removed, the electrophoretic particles can be generally stable. Additionally, providing a subsequent electric charge can alter a prior configuration of particles. Such displays may include, for example, a plurality of anisotropic particles and a plurality of second particles in a suspending fluid. Application of a first electric field may cause the anisotropic particles to assume a specific orientation and present an optical property. Application of a second electric field may then cause the plurality of second particles to translate, thereby disorienting the anisotropic particles and disturbing the optical property. Alternatively, the orientation of the anisotropic particles may allow easier translation of the plurality of second particles. Alternatively or in addition, the particles may have a refractive index that substantially matches the refractive index of the suspending fluid.

As already mentioned, an encapsulated electrophoretic display can be constructed so that the optical state of the display is stable for some length of time. When the display has two states that are stable in this manner, the display is bistable, within the meaning of that term as previously defined; if more than two states of the display are stable, then the display is multistable. However, whether a display is effectively bistable state depends upon the display's application. A slowly decaying optical state can be effectively bistable if the optical state is substantially unchanged over the required viewing time. For example, in a display that is updated every few minutes, a display image that is stable for hours or days is effectively bistable for a particular application. Alternatively, it is possible to construct encapsulated electrophoretic displays in which the image decays quickly once the addressing voltage to the display is removed (i.e., the display is not bistable or multistable). Whether or not an encapsulated electrophoretic display is bistable, and its degree of bistability, can be controlled through appropriate chemical modification of the electrophoretic particles, the suspending fluid, the capsule, and binder materials.

An encapsulated electrophoretic display may take many forms. The capsules of such a display may be of any size or shape. The capsules may, for example, be spherical and may have diameters in the millimeter range or the micron range, but are preferably from about ten to about a few hundred microns. The particles within the capsules of such a display may be colored, luminescent, light-absorbing or transparent, for example.

From the foregoing description, it will be seen that die encapsulated electrophoretic media and displays of the present invention preserve all the advantages of prior art encapsulated electrophoretic media and displays, while rendering the encapsulated electrophoretic medium less susceptible to damage from pressure exerted upon the medium. Thus, the media and displays of the present invention may be useful in applications where prior art encapsulated elec-

trophoretic media and displays cannot be used because of their susceptibility to pressure damage.

While the invention has been particularly shown and described with reference to specific preferred embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. An encapsulated electrophoretic medium comprising a layer of capsules, each of said capsules comprising a liquid and at least one particle disposed within the liquid and capable of moving therethrough on application of an electric field to the medium, the layer of capsules having the form of a lamina having a thickness substantially less than its other two dimensions, the medium further comprising a plurality of spacers dispersed among the capsules, the dimension of the spacers parallel to the thickness of the lamina being from 0.9 to 1.0 times this thickness.

2. A medium according to claim 1 wherein at least one of the spacers has substantially the form of a sphere.

3. A medium according to claim 1 wherein at least one of the spacers has substantially the form of a rod.

4. A medium according to claim 1 wherein the spacers are formed from glass and/or a polymeric material.

5. A medium according to claim 1 wherein the spacers are formed from a substantially transparent material.

6. A medium according to claim 1 wherein the ratio of spacers to capsules is in the range of from about 1:100 to about 1:1,000,000.

7. A medium according to claim 6 wherein the ratio of spacers to capsules is in the range of from about 1:1,000 to about 1:100,000.

8. A medium according to claim 1 wherein the liquid has an optical property differing from that of the at least one particle.

9. A medium according to claim 1 wherein the liquid has disposed therein at least one first particle having a first optical property and a first electrophoretic mobility and at least one second particle having a second optical property different from the first optical property and a second electrophoretic mobility different from the first electrophoretic mobility.

10. A medium according to claim 9 wherein the first and second particles bear charges of opposite polarity.

11. A medium according to claim 1 further comprising a binder disposed between the capsules.

12. An electrophoretic display comprising an encapsulated electrophoretic medium according to claim 1 in combination with first and second electrodes disposed on opposed sides of the electrophoretic medium, at least one of the first and second electrodes being light transmissive.

13. An electrophoretic display according to claim 12 further comprising first and second substrates disposed on opposed sides of the electrophoretic medium, the first and second substrates being secured to the first and second electrodes respectively.

14. An electrophoretic display according to claim 13 wherein the first and second electrodes and the first and second substrates are all flexible.

15. An electrophoretic display according to claim 12 further comprising touch sensing means disposed on the opposed side of one of the first and second electrodes from the electrophoretic medium.

16. An electrophoretic display according to claim 12 wherein at least one of the spacers is secured to, or integral with, one of the first and second electrodes.